FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Techniki sztucznej inteligencji**
Name in English:	**Artificial Intelligence Techniques**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR052135**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30			15	
Number of hours of total student workload (CNPS):	60			30	
Form of crediting:	crediting with grade			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	2			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points for direct teacher-student contact (BK) classes:	1.40			0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basics of power system control, digital signal processing and numerical methods
2. Practical skills of using MATLAB and ATP-EMTP software

SUBJECT OBJECTIVES

C1. Acquaintance of knowledge related artificial intelligence techniques application to digital power system protection and control systems

C2. Acquiring practical skills to design and analyze control and protection units for power systems, with application of artificial intelligence techniques

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 Possesses knowledge related to expert systems: basic features, structure, inference methods, conflict resolution strategies, application fields.

PEU_W02 Possesses knowledge related to fuzzy logic systems: fuzzy signals, membership functions, fuzzy settings, fuzzyfication and defuzzyfication methods, realization of multi-criteria algorithms.

PEU_W03 Possesses knowledge related to artificial neural networks (features, neurone types, activation functions, neural network structures, learning methods, application fields) as well as genetic algorithms (evolutionary strategies, genetic modifications).

relating to skills:

PEU_U01 Is able to apply expert systems for power system control and protection purposes.

PEU_U02 Is able to apply fuzzy logic technique for power system control and protection purposes.

PEU_U03 Is able to apply artificial neural networks as well as genetic algorithms for power system control and protection purposes.

relating to social competences:

PEU_K01 Is able to carry out a complex engineering project in a competent way, unaided, undertaking multi-criterial analysis.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Introduction. Setting rules of course crediting. Definition of artificial intelligence (AI), AI as a branch of science, AI techniques in power systems, statistics of AI application in power system protection and control.	2
Lec 2	AI approach to protection and control tasks – problems of contemporary digital protection systems, protection relay as a classifying unit, protection tasks as pattern recognition tasks.	2
Lec 3	Expert Systems (ES) – definitions, knowledge base, data base, inference mechanisms.	2
Lec 4	ES – semantic rules and structures, acquisition of rules, inference methods, conflict resolving strategies.	2
Lec 5	Expert Systems – application fields, examples.	2
Lec 6	Fuzzy Logic (FL) – basics of fuzzy sets theory, operations on fuzzy sets, fuzzy arithmetic. Linguistic variables, operators of aggregation, fuzzy reasoning.	2
Lec 7	Elements of FL in power system protection – fuzzy criteria signals, fuzzy settings, fuzzy comparison, amount of information, multi-criterial decision making.	2
Lec 8	Examples of FL technique application in power system protection.	2
Lec 9	Artificial Neural Networks (ANN) – neurone models, activation functions, multilayer perceptrons, feed-forward networks.	2
Lec 10	ANN architectures: feed-forward networks, ANNs with feedback connections, Hopfield networks, Kohonen networks.	2
Lec 11	ANN design problems – network structure selection, generation of training patterns, training algorithms with and without the teacher, learning process acceleration techniques, knowledge generalisation vs. overfitting.	2
Lec 12	Examples of ANN application in power system control.	2
Lec 13	Genetic algorithms – evolutionary strategies, genetic modification of individuals, genetic optimisation, application examples.	2
Lec 14	Comparison of described AI techniques, hybrid structures, examples.	2
Lec 15	Crediting test.	2
	Total hours:	**30**

Form of classes - project		**Number of hours:**
Proj 1	Design and implementation of an expert system for chosen decision task.	4
Proj 2	Design and evaluation of the fuzzy logic based measurement/decision unit.	4
Proj 3	Design and evaluation of the neural network based measurement/decision unit.	4
Proj 4	Implementation of genetic optimization procedures for selected measurement/decision task.	2
Proj 5	Presentations of executed projects, crediting.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Informative lecture.
N2. Matlab and ATP-EMTP programmes.
N3. Project presentation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Participation in the course.
F2(W)	PEU_W01 PEU_W02 PEU_W03	Final colloquium/test.
P(W)	P = 0,1F1 + 0,9F2	
F1(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity during the classes.
F2(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Presentation of the projects done.
P(P)	P = 0,2F1 + 0,8F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Rebizant W., Szafran J., Wiszniewski A., Digital signal processing in power system protection and control, Springer, London 2011
[2] Russel S.J., Norvig P., Artificial intelligence: a modern approach, Prentice Hall, Pearson, 2010
[3] James J. Buckley, Esfandiar Eslami, An introduction to fuzzy logic and fuzzy sets, Heidelberg Physica-Verlag, 2002
[4] Dillon T.S. and Niebur D. (edited by), Neural Network Applications in Power Systems, CRL Publishing Ltd., London 1996
[5] Liebowitz J., The Handbook of applied expert systems, Boca Raton, CRC Press, 1998

SECONDARY LITERATURE:

[1] Gottlob G. And Nejdl W. (ed. by), Expert Systems in Engineering: Principles and Applications, Proceedings of the International Workshop, Vienna, Austria, Sept. 1990
[2] Cichocki A., Unbehauen R., Neural Networks for Optimization and Signal Processing, John Wiley & Sons, 1993
[3] Yager R.R. and Filev D.P., Essentials of Fuzzy Modelling and Control, J. Wiley & Sons, Inc., New York, USA, 1994
[4] Ringland G.A. and Duce D.A. (ed. By), Approaches to Knowledge Representation: An Introduction, Research Studies Press Ltd., Wiley & Sons, Chichester, England, 1988
[5] Pao Y.A., Adaptive Pattern Recognition and Neural Networks, Addison-Wesley, Reading, MA, 1989

SUBJECT SUPERVISOR

Waldemar Rebizant, waldemar.rebizant@pwr.edu.pl